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BUILDING MATERIALS AND STRUCTURES

REPORT BMS97

Experimental Dry-Wall Construction With Fiber Insulating Board

by

CHARLES G. WEBER

and ROBERT C. REICHEL

NATIONAL BUREAU OF STANDARDS

BUILDING MATERIALS AND STRUCTURES REPORTS

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Experimental Dry-Wall Construction With Fiber Insulating Board

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ISSUED MAY 7, 1943

The National Bureau of Standards is a fact-finding organization; it does not "approve" any particular material or method of construction. The technical findings in this series of reports are to be construed accordingly.

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Foreword

Previous reports describe the properties of fiber insulating boards with particular reference to their suitability for use in the construction of low-cost houses. This report contains information on methods of application that permit a free choice of design and finish of the boards in dry-wall construction. Difficulties which heretofore limited the choice of wall design were eliminated in experimental walls by new methods of fastening the boards.

LYMAN J. BRIGGS, *Director.*

Experimental Dry-Wall Construction with Fiber Insulating Board

by CHARLES G. WEBER *and* ROBERT C. REICHEL [1]

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ABSTRACT

The use of fiber insulating boards for the interior surfacing of walls and ceilings of houses has heretofore been limited with respect to choice of design or finish of the walls. The relatively high expansivity of the material with variations in the humidity of the surrounding air has made paneling necessary because molding or batten strips were required to conceal unsightly joints. It was found possible to overcome the difficulty and make paneling unnecessary. This was done by eliminating the usual nailing and substituting the use of invisible, flexible fasteners that permit the entire surface of a wall or ceiling to expand and contract as a unit.

Several methods of fastening the boards to obtain this result were developed. Use of them permitted the successful application of all of the decorative treatments normally applied to a plaster wall, without restriction as to surface design.

I. INTRODUCTION

Dry-wall construction may be defined as a type of construction that eliminates the introduction of water during the application of the surfacing of the walls and ceilings of homes. Its main objective is to speed and simplify construction and eliminate the drying-out period required for the conventional plaster surfaces. Fiber building boards have been extensively used for this purpose for years, but certain inherent properties of the material have greatly restricted its utility. The expansion and contraction of fiberboards with variations in the humidity of the surrounding air normally caused decorative finishes to break at the joints. The necessity of covering unsightly joints with batten or molding strips limited the choice of wall design to paneled effects.

This investigation was made with the cooperation of the Insulation Board Institute to find ways of overcoming the difficulties with joints between the individual boards by new or improved methods of application of the material. To obtain data on the problem various methods of application were used in the construction of experimental walls, and the performance of the walls was observed during cycles of controlled variations of relative humidity.

II. CONSTRUCTION AND TESTING OF EXPERIMENTAL WALLS

The experimental walls were constructed and tested in a chamber erected for the purpose on the grounds of the National Bureau of Standards. This chamber was 16 by 20 feet with an 8-foot ceiling. The construction, exclusive of the interior finish, consisted of 10-inch lap siding over $^{25}/_{32}$-inch fiber sheathing. The studs were spaced 16 inches on centers.

The inside surfaces of the four outside walls were finished as test walls, and in addition experimental wall sections were erected in the chamber on wood studs. Each of these sections was 8 feet wide and 7 feet 8 inches high, as shown in figure 1. The framework was number 1 common Douglas fir, and the studs were spaced 16 inches on centers, with top and bottom plates nailed securely. Each frame was stiffened with two 1- by 4-inch diagonal braces.

The chamber was heated by an oil-burning space heater. High humidity conditions were obtained by circulating air over shallow pans of warm water, and low humidities by substituting shallow pans of calcium chloride. A

[1] Research Associate at the National Bureau of Standards, representing the Insulation Board Institute.

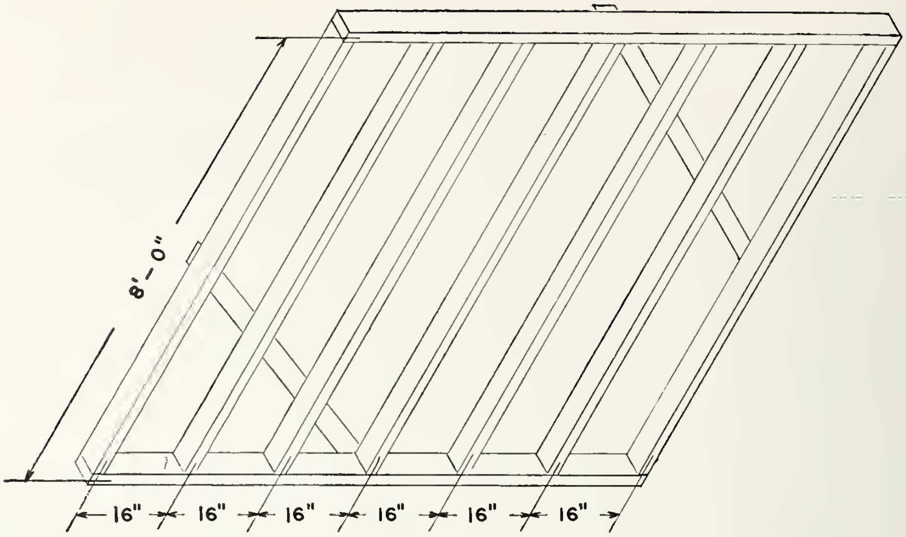

FIGURE 1.—*Framing used for experimental wall sections.*

continuous record of the relative humidity was kept by a recording hygrometer, which was checked daily with wet- and dry-bulb readings.

Tests were made on seventeen types of construction which differed mainly with respect to methods of fastening the insulating boards to the studs. A variety of decorative treatments was used, and different types of joints were included. The following conditions of relative humidity were maintained, in the order given, until equilibrium was reached as indicated by no further movement of the boards: 55, 85, 25, 85, 18, and 75 percent.

III. PERFORMANCE OF WALL CONSTRUCTIONS

The simplest method of attaching insulation board to framing is by nails, and this is the method most widely used in the past. Various methods of nailing the boards securely to the studs were used (in experimental walls). However, in every instance, nails proved unsatisfactory for one or more reasons. The movement of the boards caused the surfaces to compress or tear at the nails and produced unsightly cracks at the joints, regardless of the type of treatment. Papered walls cracked at the joints, and the nail heads showed prominently through the paper. Hence it appears that nailing directly to studs restricts the surface treatment to some type of paneling in which the nails are confined mostly to the edges and the joints covered by the molding strips which form the panels. Figures 2 and 3 show distortion at nail heads and cracks at the joints on the painted surface of boards.

Pasting to the studs is another method of fastening insulating boards. This method proved about as unsatisfactory as nailing, except that no unsightly nail heads marred the surface. Cracking at joints and buckling between studs occured to about the same extent as on nailed walls, and in addition, there was a tendency for the boards to loosen from the studs along the joints, due to movement of the boards. This type of wall requires the covering of joints, thereby making panel effects as essential as when the boards are nailed.

The principle of rigidly fastening boards to the studs with either nails or paste proved unsatisfactory on the experimental walls as it has in practice because it permits the individual boards to expand and contract as units. To overcome this fault several methods of fastening were tried which involved the use of flexible fasteners designed to allow movement in any direction of the entire wall surface as a unit. This effect was obtained by two general methods of fastening.

On wall section *J*, ½-inch insulation boards 4 feet by 7⅔ feet were attached by means of concealed mechanical fasteners of a type that

Figure 2.—*Distortion at nail heads on fiberboards nailed to studs.*

Figure 3.—*Unsightly cracks at joints between fiberboards nailed to studs.*

allowed the surface covering to move laterally, independent of the studs, as the boards expanded or contracted. The fasteners were designed to hold the boards firmly against the studs and at the same time allow sufficient movement laterally for normal expansivity. The fasteners, which were designed at the Bureau, are shown in figure 4. The fasteners, *A*, were nailed to the sides of the studs as illustrated by *E*, and a spreader of design *B* or *C* was placed on each as in *D*. The boards were brought into contact with the fasteners in the correct final location. Then, using a wood block to prevent marring of the surface, and starting with one of the fasteners on an intermediate stud, the board was driven on the bottom row of fasteners. A temporary wood strip was nailed over the bottom of the board to prevent loosening or shifting, and the board was driven on the remaining fasteners, working upward one row at a time and taking the intermediate studs first. The manner in which the fastener points are spread on entering the insulation boards is illustrated by *E*.

Wall section *K* was surfaced with ½-inch boards attached rigidly to special furring strips that were attached to the studs by a method that permitted lateral movement of the furring strips on the studs. The strips were made of pressed fiberboard ⅛ inch in thickness, and the insulation boards were fastened to them with adhesive. The design of the furring strips and method of using them are shown in figure 5. The strips were parallel to the studs and the front surfaces covered with adhesive. The insulation boards were then applied against the adhesive, using temporary nailing to hold them in place until the adhesive had set.

Wall section *M* was surfaced with ½-inch insulation boards fastened securely to ordinary 1- by 2-inch wood furring strips with nails. In this instance the furring strips were fastened to the studs with a heavy, flexible clip [2] of

[2] Olsen Floating Wall Clips, The Patent and Licensing Corp., New York, N. Y.

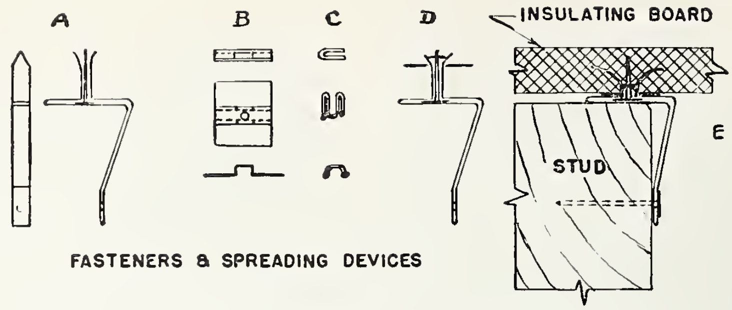

FIGURE 4.—*Concealed, flexible fastener devised at the Bureau.*

commercial manufacture. This type of construction permitted the entire surface of the wall, consisting of the insulation boards attached rigidly to the furring strips, to expand and contract as a unit by movement of the furring strips on the studs. This was another application of the principle used in wall section *K*. The clips securing the furring strips to the studs were countersunk into the strips so as not to interfere with the fitting of the insulation boards against the strips. The construction of this wall section is shown in figure 6. The gap between the boards near the bottom is necessary to permit nailing the baseboard in the conventional manner without affecting the resilience of the wall surface.

Wall section *N* was the same as section *M* in all respects, except that ¾-inch insulation board was used instead of ½-inch board.

Wall section *O* was surfaced with ½-inch insulation board mounted with wood furring strips as on sections *M* and *N*, but cut into sections to form two expansion joints between the floor and ceiling. Grounds or nailing strips equal in thickness to the combined thickness of the furring strips and the insulation board were placed in these joints and nailed firmly to the studs but not fastened to the furring or fiberboards. The board was cut in widths to conform to the lengths of the strips. Hence, the finished wall had two horizontal joints, one approximately 1 foot below the ceiling and the other 4 feet below the first. These joints were covered with a picture molding and a chair rail respectively, which were nailed to the grounds so as to extend over the edges of the insulation boards about ½ inch. The insulation boards were fastened to the furring strips rigidly with concealed fasteners of commercial design, and the furring strips were secured to the studs with the flexible clips as in sections *M* and *N*. The construction of wall section *O* is illustrated in figure 7.

These wall sections all gave excellent results.

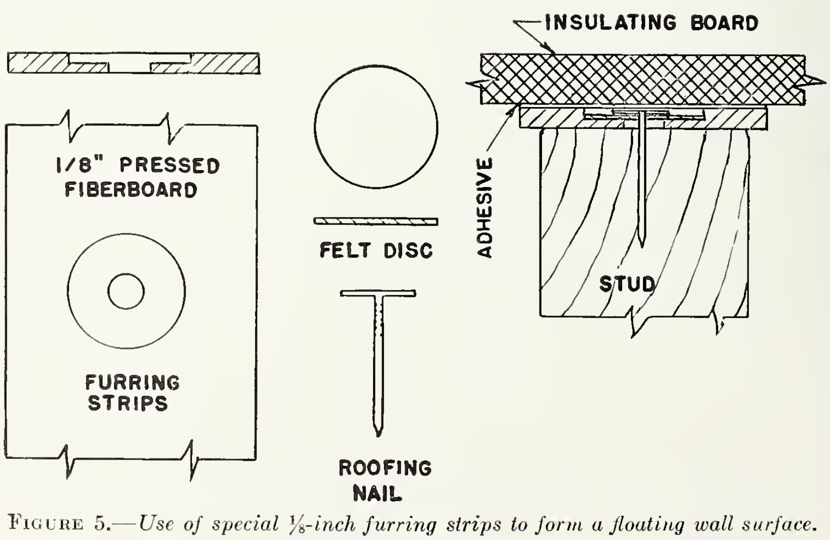

FIGURE 5.—*Use of special ⅛-inch furring strips to form a floating wall surface.*

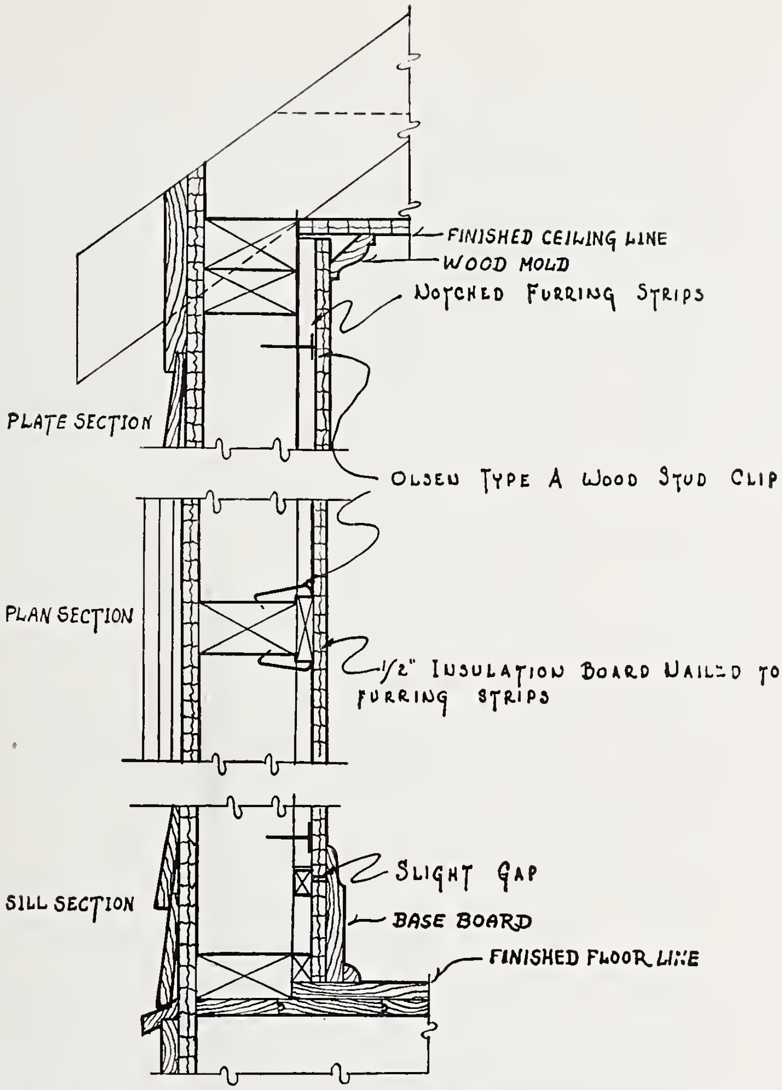

FIGURE 6.—*Method of forming floating wall surface in wall section M.*

Treated joints held without any tendency to crack, and when papered or painted, the performance was entirely satisfactory. It is essential in this type of construction to keep the boards unrestricted at the edges, which should all be concealed with trim, which may fit snugly against the board but must not be fastened to it. These types of construction permit unrestricted decorative treatment, as does the conventional plaster-surfaced wall, with the exception of section *O*. This type requires the use of chair rail and picture molding. It is, however, less difficult to construct than the others, and has the advantage of concealed expansion joints, which tend to distribute more evenly the movements resulting from contraction and expansion.

IV. TREATMENTS OF JOINTS

No special types of joints are required for resilient wall construction except where the insulation boards are fastened directly to the studs with flexible fasteners, as in wall section *J*. In this type of construction, the joints must have sufficient strength to hold the boards together, so that the entire wall surface will expand as a unit. In section *J*, a glued shiplap joint, sanded smooth after drying, performed satisfactorily. Other joints were made with Swedish putty, using buckram tape in one type

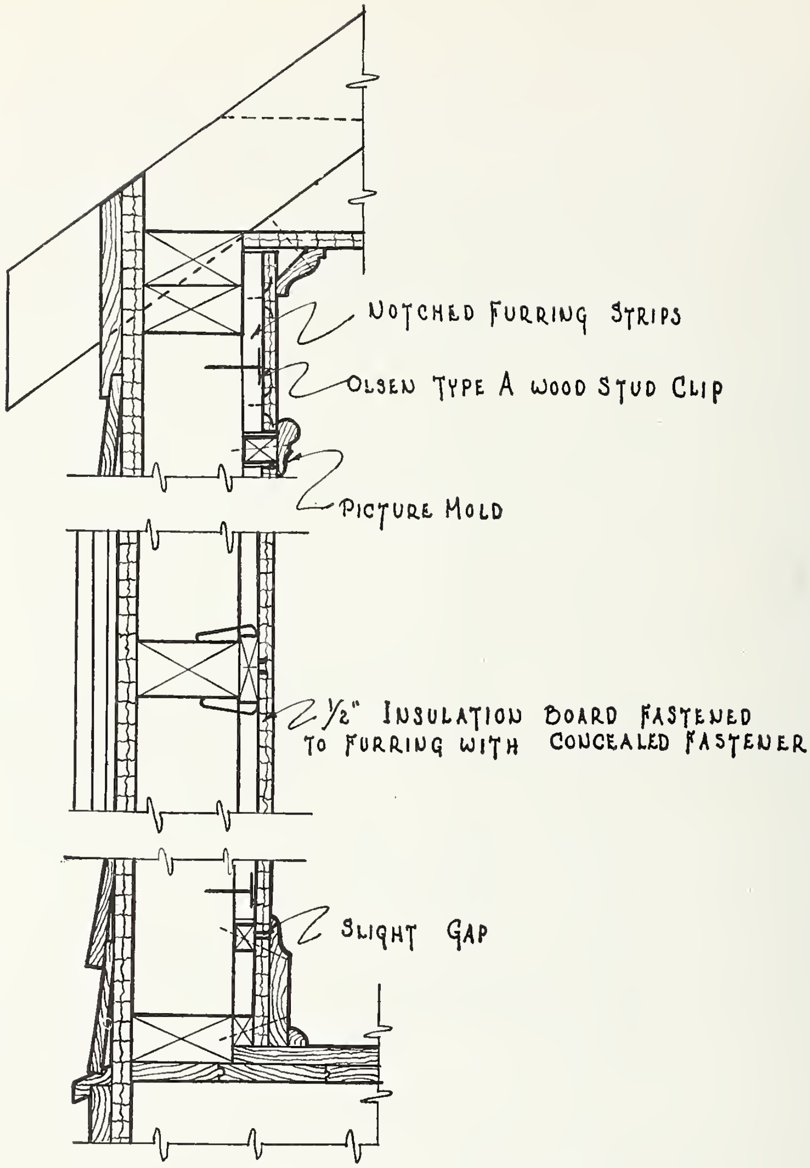

FIGURE 7.—*Method of forming floating wall surface in wall section O.*

and a metal screen strip in another. These joints are illustrated in figure 8.

In construction where the insulation boards are fastened rigidly to the furring strips, as in wall sections *K*, *M*, *N*, and *O*, there is no strain on the joints, and they can be designed for appearance only. On these experimental walls, joints were prepared for papering or painting by simply sanding them smooth with a belt sander, and excellent results were obtained. The joints in walls that are to be painted can be filled and sanded smooth. Swedish putty worked well as a filler and other crack fillers will doubtless prove satisfactory. Ordinary putty does not work well, because the oil from the putty is absorbed too rapidly by the board. Plastic wood dries very hard and sometimes tends to chip out on sanding.

V. DECORATIVE TREATMENTS

Due to the porous nature of the material, a sizing or priming coat was found necessary on all boards except the factory-decorated ones. There was a tendency, with some of the boards,

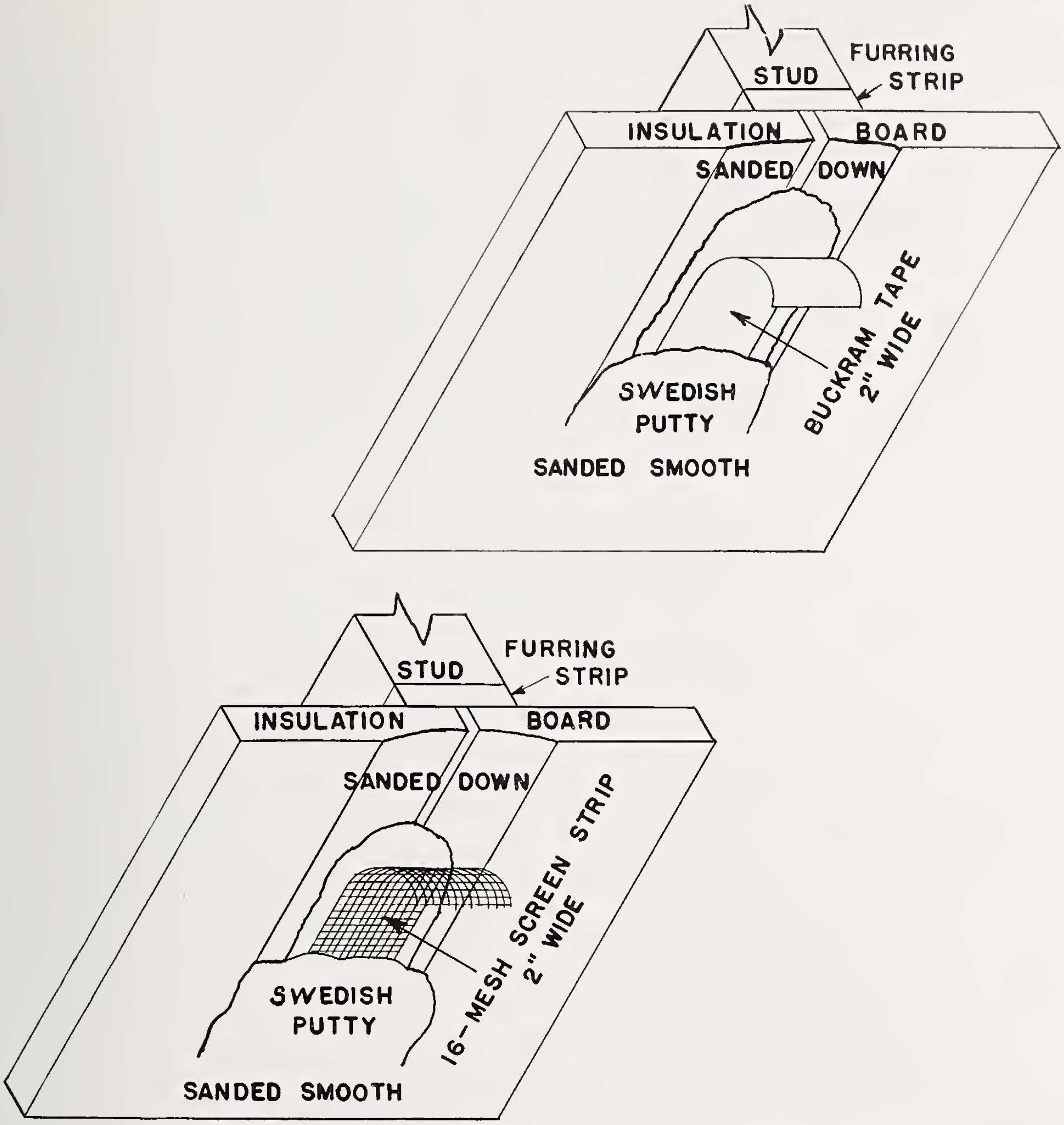

FIGURE 8.—*Method of forming concealed joints in fiber insulation boards.*

for the surface fibers to form a fuzz on the surface when brushed. This was eliminated readily by sanding the surface lightly after the priming coat was applied.

The difference in texture between the surfaces of the boards and the fillers used in joints was a troublesome problem with painted walls. This was particularly true when relatively rough-surfaced boards were used, and for some of these boards the duplication of the board texture in the filler was impractical. The smooth-surfaced boards gave no difficulty. Plastic paints of casein base, and of oil base, worked satisfactorily. The latter type required a sizing coat, but the casein type worked well on unsized surfaces.

Wallpaper and cloth-base wall coverings can be applied with ordinary paperhanger's paste on the sized boards. No difficulty was encountered in applying wallpaper, but no satisfactory method of removing it for a subsequent coat has been found.

VI. SUMMARY AND CONCLUSIONS

The use of fiber insulating boards for the surfacing of walls and ceilings in dry-wall construction restricts the choice of surface design and decorative finishes, when the boards are nailed to the stud in the conventional manner.

The restrictions can be practically eliminated by special methods of application. These methods embody the principle of "floating" the wall surface, thereby permitting the entire face of the wall to expand and contract as a unit, independent of the frame, which should have adequate diagonal bracing. It can be accomplished by fastening the boards from the back, either rigidly to furring strips that are in turn secured to the studs with floating clips, or directly to the studs with floating clips.

The wall surface obtained with fiber insulating boards correctly applied is practically unrestricted with respect to choice of design or finish. It can be papered or painted or given any other decorative treatment applicable to plaster walls if appropriate attention is given to the filling and leveling of joints.

Washington, January 25, 1943.

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